8/PRTS JC03 Rec'd PCT/PTO 18 SEP 2001
WO 00/55951 PCT/GB00/00950
09/936960

ENCLOSURE FOR HARDWARE

This invention relates to a conduction-cooled hardware enclosure and to a method of producing the same.

It is known to provide high-strength sealed enclosures for electronic hardware, where such hardware needs to be protected from the external atmosphere. The hardware in the sealed enclosure is cooled by conduction, the body of the enclosure having a low thermal impedance to carry heat from the hardware to the external atmosphere. The hardware needs to be protected from the external atmosphere in order, for example, to avoid moisture reaching the hardware. There are a number of known types of chassis for such an enclosure. One known chassis is produced by casting the chassis as one piece of metal. A second known chassis is formed of elongate pieces of machined metal that are attached together by screws to form the chassis and the chassis then dip-brazed at 1000°C in a salt bath. However, the production of either such chassis is undesirably expensive. A third known chassis is formed as per the second type, but without dip-brazing. The resulting chassis, however, is structurally weak, and if an enclosure made with such a chassis is dropped or suffers any other high impact then the chassis is likely to be distorted, with resulting damage to the enclosure.

GB-A-1512899 discloses a construction system for cabinets each comprising a framework covered with panels, which framework comprises elongate frame members which are releasably connectable together by means of connecting elements and connecting screws. The connecting elements include cubic corner elements which are each provided with three plug members projecting therefrom and adapted to engage within respective ends of the frame members, which may be made from a suitable steel alloy. The corner elements are formed by hot pressing in a suitable aluminium alloy.

According to a first aspect of the present invention, there is provided a conduction-cooled hardware enclosure comprising first and second sides opposite to each other extending in respective substantially parallel planes, each side comprising portions of at least one one-piece element of

thermally conductive material, said portions extending in the plane of the side, each element including a projecting portion extending towards the opposite side of said first and second sides, and fixing means fixing the projecting portion(s) extending from the first side to the projecting portion(s) extending from the second side, characterised in that the or each one-piece element is formed by casting and machining.

According to a second aspect of the present invention, there is provided a conduction-cooled hardware enclosure comprising first and second sides opposite to each other extending in respective substantially parallel planes, each side comprising portions of at least one one-piece element of thermally conductive material, said portions extending in the plane of the side, each element including a projecting portion extending towards the opposite side of said first and second sides, and fixing means fixing the projecting portion(s) extending from the first side to the projecting portion(s) extending from the second side, characterised in that said projecting portion has one or both of the following features:-

(i) said projecting portion extends into at least 5% of the spacing between said first and second sides, and

(ii) said projecting portion has a length at least equal to its own thickness.

According to a third aspect of the present invention, there is provided a conduction-cooled hardware enclosure comprising first and second sides opposite to each other extending in respective substantially parallel planes, each side comprising portions of at least one one-piece element of thermally conductive material, said portions extending in the plane of the side, each element including a projecting portion extending towards the opposite side of said first and second sides, and fixing means fixing the projecting portion(s) extending from the first side to the projecting portion(s) extending from the second side, characterised in that said fixing means comprise dowel means closely received in recesses formed in the projecting portions.

According to a fourth aspect of the present invention, there is provided a method of producing an enclosure for conduction-cooled hardware, comprising forming at least two one-piece elements by casting and machining, each element including projecting portions, and fixing together said projecting portions in assembling said enclosure.

Owing to these aspects of the invention, it is possible to provide a conduction-cooled hardware enclosure that is structurally strong, but can be manufactured relatively cheaply. The one-piece elements are relatively cheap to produce compared to casting an entire chassis, but still provide the requisite structural integrity.

According to a fifth aspect of the present invention, there is provided a method of producing a conduction-cooled hardware enclosure comprising providing a plurality of enclosure pieces of a range of differing sizes and usable in assembling enclosures of respective differing sizes, selecting some of those pieces, assembling a thermally conductive enclosure of a desired size and including the selected pieces and installing electronic hardware in said enclosure in thermally conductive communication with said enclosure.

Owing to this aspect of the invention, it is possible to construct easily conduction-cooled hardware enclosures of a range of differing sizes, by choosing the size of enclosure piece appropriate to produce an enclosure of the desired size.

In order that the invention may be clearly understood, and readily carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:-

Figures 1, 2 and 3 are respectively side, end and plan views of a chassis for a conduction-cooled hardware enclosure,

Figure 4 is a fragmentary end view of a detail of the chassis taken on the line IV-IV of Figure 3 showing two plates about to be fixed to the chassis,

Figure 4a is a perspective view of a corner piece of the chassis,

Figure 5 is a view similar to Figure 4 with the plates now fixed to the chassis,

Figure 6 is a fragmentary plan view of a join between two pieces of the chassis,

Figure 7 is a plan view of a piece of an alternative embodiment of the enclosure chassis,

Figure 8 is a side view of the piece of Figure 7, and

Figure 9 shows a section on the line IX-IX of Figure 7.

Referring to Figures 1 to 3, a chassis 1 is made up of six triskelion-form corner pieces 2 and joining pieces in the form of straight links 3. The corner pieces 2 are cast, each as one piece, in metal, e.g. aluminium, or carbon fibre and then machine-finished, particularly milled, to shape to achieve good orthogonal strength. The links are also made of metal, e.g. aluminium, or carbon fibre and may also be manufactured by casting and machine-finishing. Panels are fitted to the chassis by fixing them to the corner pieces 2 and/or the links 3. The panels are for cladding and act as heat sinks to conduct away excess heat from the electronic hardware that will be used in the enclosure in its working environment.

The corner pieces 2 (seen more clearly in Figure 4a) are formed with three projecting portions 2a each with a recess 2b in its end. The projecting portions 2a extend through a significant distance. To achieve the requisite structural strength, the portion 2a extends into at least 5% of the spacing between two sides of the enclosure 1 and/or has a length at least equal to its own thickness. Ideally the length of the portion 2a should be at least three times its own thickness. The same principle applies to the length of the projecting portion 21 of the plate-form casting 20 of Figures 7 to 9.

In Figure 4 two cladding panels 4 and 5 are shown about to be fitted to the chassis 1. The panel 5, in the form of a top cover has an internal portion 6 that mates with a section 7 of the chassis. Similarly the panel 4, in the form of a side plate, has a portion 8 that mates with a section 9 of the chassis. The panel 4 also has a portion 10 that is within

the chassis 1 and facilitates the heat sink properties of the enclosure. Each panel is supplied with respective holes 11 that each match up with respective holes 12 in the chassis 1 for accepting screws, e.g. of mild steel, for fastening the panels to the chassis 1.

Figure 5 shows the chassis 1 with the panels 4 and 5 now affixed. Each of the holes 12 is fitted with a heli-coil insert to provide a stronger thread in the hole that will then receive the screw to fix the panel in place. "O" ring seals 15, that are fitted between the panel 4 or 5 and the chassis 1, are provided to ensure a full hermetic and electro-magnetic emission seal. The machine-finishing of the pieces 2 (and the links 3) promotes good sealing of the enclosure 1.

Figure 6 shows a join between two pieces of a chassis. This join could be between two corner pieces 2, between two links 3 or between a corner piece 2 and a link 3. Owing to the universality of the join, any size of chassis can be constructed by choosing the length and number of links 3 appropriate to the size of enclosure required. Each pair of adjacent ends of the pieces 2 and 3 is formed with respective recesses closely receiving respective halves of respective dowels 16 preventing relative lateral movement of the ends of each pair. An anti-rotation pin 19 (seen in Figure 5) is present near a corner of one end of each pair and mates with a corresponding recess on the other end of each pair. This prevents the two ends of the pair from rotating relative to each other during final fixing of the dowel 16. The dowel 16 is held fixed relative to each end by two pairs of force-fit pins 17. The two pairs of pins 17 for each end are in respective planes at right-angles to each other. Between the two ends is an "O" ring seal 18 to help ensure an hermetic seal. The use of the pins 17 and dowel 16 enable a very tight tolerance to be achieved, which is necessary to obtain the hermetic seal.

In Figures 7 to 9 the chassis 1 is formed of two profiled, plate-form castings (of which one is shown and referenced 20) and, if desired, links 3 (according to the

version of Figures 1 to 6) therebetween. Each casting is a single piece of metal e.g. aluminium, with projecting legs 21 that are joined to the legs of the opposite casting (or the links 3) in the same manner as the corner pieces 2 are joined to each other or the links 3 in the previous embodiment. The plate-form castings (and the links 3) are machine-finished, particularly to promote good sealing of the enclosure 1.